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Note by the Secretary-General

The Secretary-General has the honour to transmit to the Security Council the twenty-second quarterly report on the activities of the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) (see annex). It is submitted by the Acting Executive Chairman of UNMOVIC in accordance with paragraph 12 of Security Council resolution 1284 (1999) of 17 December 1999.

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Annex

Twenty-second quarterly report on the activities of the United Nations Monitoring, Verification and Inspection Commission in accordance with paragraph 12 of Security Council resolution 1284 (1999)

I. Introduction

1. The present report, which is the twenty-second submitted in accordance with paragraph 12 of Security Council resolution 1284 (1999), covers the activities of the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) during the period from 1 June to 31 August 2005.

II. Developments

2. During the period under review, the Acting Executive Chairman has continued the practice of briefing the respective Presidents of the Security Council, representatives of Member States and officials of the Secretariat on the activities of UNMOVIC.

3. From 20 to 22 June, the Acting Executive Chairman visited Cyprus, where he held consultations with the Permanent Secretary of the Ministry of Foreign Affairs and officials of the United Nations Peacekeeping Force in Cyprus (UNFICYP), and also visited the facilities of the UNMOVIC field office.

4. UNMOVIC has noted that the national report (S/AC.44/2004/(02)/116 of 13 April 2005) submitted by Iraq to the Security Council pursuant to Council resolution 1540 (2004) indicates that the National Monitoring Directorate of the Ministry of Science and Technology continues to function. The National Monitoring Directorate had been established to facilitate fulfilment of Iraqi obligations pursuant to Security Council resolutions relating to the disarmament of Iraq of weapons of mass destruction. The report outlines the various measures taken by the Directorate to implement its work, including following the monitoring of the implementation of the monitoring, verification and inspection plan and the ongoing monitoring system for dual-use materials and equipment, as well as the mechanism for the import and export of such materials and equipment.

Status of sites, dual-use equipment and materials subject to monitoring

5. UNMOVIC imagery analysts have continued to review the status of sites subject to inspection and monitoring in Iraq. As stated in the previous quarterly report (S/2005/351), of the 411 sites inspected in the period from November 2002 to March 2003, post-war high-resolution imagery has been examined for 378 sites, including those considered the most important. The analysts have determined that 118 sites have been cleaned to varying degrees, up from 109 sites mentioned in the previous report.

Compendium

6. The Commission has continued its work on the compendium of Iraq's proscribed weapons and programmes. It provides a detailed technical description of Iraqi weapons and programmes, with an emphasis on lessons that can be drawn from both the nature of the programmes and the experience gained in the process of their verification by United Nations inspectors. After compiling the first draft of the compendium, as outlined in the Commission's twenty-first quarterly report, the Commission has prepared an extensive draft summary of the compendium. The body of the compendium contains sensitive information on technological details of research and production by Iraq of chemical and biological weapons and development of its indigenous missile systems in combination with information on former suppliers to Iraq. The draft summary, however, provides a more general description of proscribed programmes, with an emphasis on lessons learned by United Nations inspectors. An extract containing the biological section of the summary of the compendium is attached as an appendix to this present report.

III. Other activities

Review of the ongoing monitoring and verification plan (missile provisions) by the panel of external technical experts

7. Paragraph 26 of the plan for ongoing monitoring and verification approved by the Security Council in resolution 715 (1991) allows UNMOVIC, after informing the Security Council, to update and revise the lists of items and materials to which the monitoring plan applies. In June 2005, the Commission convened a panel of six external technical experts to participate in a technical review of the missile provisions and the associated list of dual-use items, equipment and technology (annex IV of the plan). The panel (comprising experts from Argentina, France, the Netherlands, Romania, the United States of America and the United Kingdom of Great Britain and Northern Ireland) met for four days and made a number of specific and general recommendations regarding the missile provisions, in the light of the United Nations experience of monitoring and verification, the changed situation in Iraq and technical advances in unmanned delivery systems that could be associated with the delivery of weapons of mass destruction. A similar review was conducted in November 2004 in the biological area.

IV. Other issues

Field offices

8. UNMOVIC retains a core staff of nine local nationals in Baghdad who maintain the existing offices, laboratories and other equipment at the Canal Building, which is also used by the United Nations Assistance Mission for Iraq (UNAMI). During this reporting period, the local staff created a photographic inventory of UNMOVIC equipment secured in the UNMOVIC offices and laboratories in the Canal Building as well as in the 15 large containers stored in the compound. The UNMOVIC local staff have increased the security of the Commission's offices by completely blocking two of the three former entrances, and installing steel doors to secure the single remaining entrance.

9. The personnel of the UNMOVIC field office in Cyprus consist of four staff members, two at the Professional and two at the General Service level. The office provides storage and maintenance for inspection and monitoring equipment, logistics support and support of training. The field office shipped detection and protective equipment, required to support the Biological Advanced Course, to the United Kingdom of Great Britain and Northern Ireland. Whenever appropriate, the staff of the field office has continued to work with Customs in Larnaca facilitating shipments of other United Nations agencies and to provide logistics support to UNFICYP and UNAMI.

Staffing

10. Following the departure of a number of staff, core UNMOVIC staff at the Professional level now total 46, drawn from 24 nationalities, nine of whom are women.

Technical visits, meetings and workshops

11. UNMOVIC experts attended the meeting of experts on the Biological Toxins and Weapons Convention held at Geneva in June 2005. The meeting discussed the content, promulgation, promotion of common understanding about and effective actions and adoption of codes of conduct for scientists. Participants were from Governments, international organizations and private institutions.

12. UNMOVIC was asked to provide expertise on geographic information systems and remote-sensing techniques to support inspectors in the field for an exercise conducted by the Comprehensive Nuclear-Test-Ban Treaty Organization, which was held in Kazakhstan from 10 to 29 July. The participation of an UNMOVIC expert in this exercise was without cost to the Commission.

13. Two technical seminars were conducted by UNMOVIC in New York. The first was a demonstration and presentation on the use of Raman spectroscopy techniques in the detection of toxic industrial chemicals and agents. The second was a discussion led by a senior research fellow on the impact of international bio-security standards on the monitoring and verification of biological activities and material covered by the UNMOVIC monitoring and verification plan.

Training

14. UNMOVIC conducted one training course for inspectors on its roster in the period under review. This fourth advanced biological course was held at Swindon, United Kingdom, from 25 July to 5 August. Sixteen experts from 12 countries and UNMOVIC headquarters staff participated in the course. Its objective was to develop practical skills to prepare and carry out on-site inspections at dual-use biological production facilities. A mock inspection was conducted as part of the course. The Commission is grateful to the British Government for its support for this training course.

V. College of Commissioners

15. The UNMOVIC College of Commissioners convened in New York for its twentieth regular session on 24 and 25 August. The observer from the International Atomic Energy Agency also attended.

16. The Acting Executive Chairman briefed the Commissioners on the activities of UNMOVIC since their last session and on the planned activities for the next quarter. In addition, presentations were made on the following:

(a) The outcome of the work of a panel of external experts convened by the Acting Executive Chairman to consider possible revisions to the missile-related provisions and the associated list of dual-use items, equipment and technology in the ongoing monitoring and verification plan;

(b) The UNMOVIC information technology system and organization of the archives;

(c) Video footage from the UNMOVIC archives showing how Iraq filled chemical agent into conventionally marked munitions without distinctive features and using rudimentary methods, as an example of the new insights still being obtained in the course of preparation of the compendium.

17. The College welcomed the introductory statement by the Acting Executive Chairman and the presentations made. The College reiterated its appreciation for the considerable work being undertaken within the Commission, in particular concerning the compendium, training, development of the information technology system, and the organization of the archives. The College noted that, in its work, the Commission was considering various options in connection with the revisiting of its mandate by the Security Council, and supported the range of those activities as described by the Chairman. The College also noted that the draft summary of the compendium would shortly be made available to Commissioners for their comments and advice.

18. It was decided to hold the next meeting of the College tentatively on 21 and 22 November.

19. In accordance with paragraph 5 of resolution 1284 (1999), the Commissioners were consulted on the content of the present report.

Appendix

Biological Weapons Programme of Iraq (extracted from the compendium summary)

Development of the biological weapons programme

1. The biological weapons programme of Iraq was much smaller than its chemical weapons programme and various missile projects in its size and scale. The programme, which was the last started among Iraq's efforts in the field of weapons of mass destruction, materialized after Iraq had already developed and deployed its chemical weapons and progressed in the modification of foreign missile systems. However, the programme was the most covert undertaken of all the non-conventional weapons programmes in Iraq.

2. Although the biological work was initiated by Iraq in the 1970s, at that stage it was focused on general research into the basic parameters and characteristics of different micro-organisms but, in general, not exclusively those traditionally associated with biological warfare. As part of the programme, Iraq constructed a dedicated research facility, the Ibn Sina Centre, located on the Salman peninsula near the town of Salman Pak, some 30 km south-east of Baghdad. The Ibn Sina Centre came under the auspices of a newly created organization, Al Hazen Ibn Al Haithem Institute, which was in turn subordinated to the special security and intelligence agencies. However, this first attempt to establish a biological weapons programme in Iraq came to a halt in 1978, when the Institute was shut down by the Government for the stated reason of having achieved poor results.

3. There is no evidence available to UNMOVIC whether any work in connection with biological warfare was conducted immediately following the closure of Al Hazen Ibn Al Haithem Institute. From Iraq's declarations and interviews with Iraqi scientists, however, it is clear that some biological activities continued at Salman Pak under the auspices of the security apparatus. At the end of 1984, such activities included research on wheat smut with a view to finding suitable measures for crop protection, as well as investigating this agent as a possible weapon that would cause economic loss.

4. Military interest in the development of the biological weapons programme was first expressed by the head of Iraq's chemical weapons programme in 1983. However, no immediate practical actions were taken until 1985, when a small biological group was formed at Iraq's prime chemical weapons complex near Samarra (later also known as the Muthanna State Establishment, some 100 km north-west of Baghdad). Late in 1985, bacterial strains, basic laboratory equipment, pilot-scale production equipment and materials were procured from foreign suppliers. Two agents, botulinum toxin and anthrax, were selected as candidate biological warfare agents. The work was focused on pathogenicity and toxicity studies, characteristics of agents and methods of their production at the laboratory scale. For its work the group used the existing infrastructure of the chemical complex, including several laboratories, an inhalation chamber and an animal house.

5. By the end of 1986, the biological work at Muthanna was scaled up with the intention to produce botulinum toxin at pilot scale and a proposal was made to affiliate the single-cell protein facility at Al Taji (some 20 km north of Baghdad) to the biological weapons programme. In 1987, Iraq's chemical weapon programme

personnel considered further expansion of biological activities at the Muthanna complex to be incompatible with the other site activities and infrastructure. Consequently, the biological weapons group was transferred to the Forensic Research Department of the Technical Research Centre at Salman Pak in mid-1987. Lieutenant General Hussein Kamel was at that time the head of Iraq's special security apparatus, and since the Research Centre was established as a technical branch of the intelligence and security service, it was also directly controlled by him. Later, when Hussein Kamel became the director of the Military Industrialization Commission, the Technical Research Centre was transferred to that Commission and remained under his direct control and supervision.

6. The biological weapons programme was significantly expanded after its transfer to the Technical Research Centre. The single-cell protein facility at Al Taji was acquired, more laboratory equipment and materials were procured and additional personnel were recruited. Construction was started on a new building at Salman Pak to house a pilot-scale fermenter. Production of botulinum toxin and anthrax began with the use of bench-top fermenters, and experimentation commenced using a range of animals to study inhalation and other exposure routes and effects.

7. At the end of 1987, the scope of the biological weapons work was further expanded and research into additional bacterial agents, such as *Clostridium perfringens* and fungal toxins, such as trichothecene mycotoxins, was carried out. In 1988, Iraq also began to produce botulinum toxin at a refurbished fermentation unit at the single-cell protein facility at Al Taji. Early in 1988, Iraq also began field trials on the dissemination of biological warfare agents. These trials involved munitions supplied by the Iraqi chemical weapons programme and an aerosol spray device modified specifically for the biological weapons programme. Following a successful although hurried research and development programme and basic pilot-scale production, the biological weapons programme moved towards large-scale production which required the construction of a dedicated facility for this purpose. Salman Pak was considered to be an unsuitable site for large-scale production on the grounds of safety considerations, because of its proximity to Baghdad.

8. Iraq's main biological warfare agent production facility, Al Hakam, was built at a remote desert location (60 km west-south-west of Baghdad) in remarkably short time, during the period from March to December 1988. It would appear that Iraq, while developing Al Hakam, had also drawn important lessons from its previous weapons projects, especially the functioning of its chemical weapons complex at the Samarra site, which had been largely designed and constructed by foreign companies with the presence of their contractors on the ground. This resulted in the exposure of the true nature of that site and further led to the introduction of international trade regulations that impacted the chemical weapons programme. In contrast, Al Hakam was built in full secrecy without the involvement of any foreign companies or contractors. Information regarding its physical location, purpose and affiliation to the Technical Research Centre was strictly classified. Even contracts for the acquisition of relevant equipment and materials for Al Hakam were issued under the cover of other Iraqi organizations and agencies. Because of this secrecy, Al Hakam was not identified as a biological weapons facility prior to the 1991 Gulf war and subsequently was not subject to aerial bombardment by the coalition. Large-scale fermentation equipment for Al Hakam was sought from foreign suppliers in 1988. Nevertheless, procurement attempts failed since prospective

suppliers were not able to obtain export licenses from their national authorities. Attempts to acquire specific spray dryers also failed for the same reason. A line of fermenters and support equipment from the Veterinary Research Laboratories (later known as Al Kindi Company for the Production of Veterinary Vaccines and Drugs) at Abu Ghraib (15 km west of Baghdad) was transferred to Al Hakam, as well as equipment from the single-cell protein facility at Al Taji.

9. Early in 1989, the production of botulinum toxin was started at Al Hakam, while pilot-scale production of anthrax and aflatoxin began at Salman Pak. The production of anthrax at Al Hakam started later, in 1990. Research included laboratory-scale experiments related to the drying of anthrax. However, according to Iraq, since special dryers could not be obtained, this work did not progress. The biological weapons programme also began research on other agents, including ricin toxin and *Clostridium botulinum* spores.

10. After the invasion of Kuwait by Iraq in August 1990, the biological weapons programme increased the production of bulk biological warfare agents and began to weaponize them. To increase the production of bulk warfare agents, the Technical Research Centre acquired two additional commercial facilities, the foot-and-mouth disease vaccine plant at Al Dawrah (in the south-west suburbs of Baghdad) and the agricultural research and water resources centre (known as Al Fudaliyah, some 15 km north-east of Baghdad).

11. Unlike Al Hakam, which was built as a dedicated biological warfare facility, the plant at Al Dawrah was constructed as a legitimate turnkey facility by a foreign company in the late 1970s and early 1980s. The plant was designed for the production of vaccine for foot-and-mouth disease, which is endemic in Iraq. When the facility was utilized for the production of botulinum toxin in 1990, the production of vaccine was suspended. Several brick walls were erected to separate the zone established for biological weapons production from the area of the vaccine production. The plant was also used, after its acquisition by the biological weapons programme, for research on three viruses — camelpox, enterovirus 70 and human rotavirus. Al Fudaliyah was a legitimate civilian facility that was used for the production of the biological warfare agent aflatoxin without any significant modifications to its infrastructure.

The 1991 Gulf war and United Nations verification

12. Of the five Technical Research Centre sites involved in the Iraqi biological weapons programme, only the facilities at Salman Pak were targeted by the coalition forces during the 1991 Gulf war. In addition, there were military strikes on other suspected sites, including the Abu Ghraib baby milk factory and Al Kindi Company. Buildings and infrastructure of the Technical Research Centre's forensic department at Salman Pak used by the biological weapons programme were heavily damaged by the aerial bombardment while other facilities, such as Al Hakam, the foot-and-mouth disease vaccine plant at Al Dawrah and Al Fudaliyah, were not targeted and therefore sustained no damage.

13. After the adoption of Security Council resolution 687 (1991), in April 1991, Iraq declared that it did not possess any biological weapons or related items. In May that year, Iraq identified a number of biological facilities that worked with micro-organisms or contained fermentation equipment, including the four facilities

admitted later in 1995 to have been used in the offensive biological weapons programme.

14. Prior to the arrival of the first United Nations biological inspection team, Iraq cleaned all sites involved in the production of biological warfare agents, removed evidence of past activities, including relevant documents and records, reconfigured equipment, decontaminated and renovated buildings and structures and prepared cover stories.

15. In August 1991, Iraq informed United Nations inspectors that one of the declared facilities, Salman Pak, had been involved in a biological military research programme and reported that it had obtained 103 vials of bacterial reference strains from foreign suppliers, and provided details on the individual types, source, year of importation and quantities. Of the 103 imported vials, 13 were stated by Iraq to have been used, while 90 were handed over to the United Nations inspectors unopened.

16. From the beginning of its verification activities in Iraq, the United Nations undertook inspections to identify a variety of sites and facilities referred to it by Member States as allegedly having been involved in the Iraqi biological weapons programme. Some of the sites were not declared by Iraq, and included facilities with possible underground structures. However, no facilities inspected on the basis of such information were found to have been involved in the biological weapons programme. Al Hakam, the foot-and-mouth disease vaccine plant and Al Fudaliyah were not among suspected sites referred to the inspectors through intelligence information.

17. In May 1991, Iraq first identified Al Hakam as a legitimate biological facility intended for the future production of vaccines or other materials produced by micro-organisms such as single-cell proteins. The facility was inspected for the first time in September 1991. Several samples taken by the inspectors from different pieces of equipment at Al Hakam were analysed by one outside national laboratory and were reported to be negative for the presence of biological warfare agents.

18. In their inspection report of September 1991, the inspectors raised concerns regarding the true nature of Al Hakam and noticed several unusual features of the facility. They included the presence of multiple air-defence units around its perimeter, enhanced protection and bunker-style structures, the distant separation of different areas within the facility, the rapid construction of the site implying a strong sense of urgency, its isolation and secrecy, the presence of equipment that had been transferred from other sites, and the weak economic rationale for the purported production of single-cell protein and biopesticide. Limited scope inspections at specific locations within Al Hakam were carried out once each in 1992 and 1993, before regular monitoring activities began at the site in 1994.

19. Although the inspectors believed that the facility could have been planned as the next stage in Iraq's biological warfare programme, no evidence of its involvement in biological warfare activities was found during that period. It was assumed that the very low level of biological containment in the facility prevented it from being used for the production of dangerous pathogens and that its equipment was not suitable.

20. With regard to the foot-and-mouth disease vaccine plant at Al Dawrah, the inspectors, who visited the plant from September 1991 to 1995, identified the site capabilities for the production of biological warfare agents, but concluded that the

site was a legitimate facility since no modification to its original design was observed. No indication of its involvement in Iraq's biological warfare programme arose until Iraq declared in August 1995 its past involvement. Since extensive sampling of equipment at this facility was not performed prior to 1995, the evidence of its involvement was not uncovered prior to Iraq's declaration. The inspectors were also not aware of the involvement of Al Fudaliyah in Iraq's biological weapons programme, and did not conduct sampling and analysis during their inspections of that site.

21. By 1995, the inspectors had collected sufficient evidence to suggest that Iraq's biological warfare programme was not limited to research activities, as Iraq claimed, but had also included the production of bulk quantities of several biological warfare agents and, possibly, their weaponization. Consequently, in July 1995, under pressure from United Nations inspectors who had been investigating, inter alia, the material balance of imported growth media, Iraq finally admitted the past bulk production of biological warfare agents at Al Hakam.

22. After the defection of Hussein Kamel from Iraq in August 1995, Iraq further admitted that biological warfare agents had also been produced at two other civilian facilities, the foot-and-mouth disease vaccine plant at Al Dawrah and Al Fudaliyah. Iraq also declared that it had weaponized bulk agent but had unilaterally destroyed all bulk agents and biological weapons in 1991. The weapons included 25 special warheads for Al Hussein missiles and 157 R-400 aerial bombs, filled with biological warfare agents. With respect to weaponization, Iraq declared that warheads for Al Hussein missiles and R-400 aerial bombs had been filled with liquid biological warfare agents. Iraq also provided information on other types of aerial and artillery munitions used in field trials with biological warfare agents or simulants.

23. In 1996, the entire Al Hakam complex, including all buildings, support infrastructures, utilities, equipment and materials, was destroyed by Iraq under United Nations supervision, as well as equipment and materials used by Iraq for biological warfare purposes and remaining at Salman Pak, Al Fudaliyah and the plant at Al Dawrah. In addition, the air-handling system of the vaccine plant at Al Dawrah was permanently disabled.

24. The remnants of biological munitions which Iraq declared had been filled with *Bacillus anthracis*, botulinum toxin and aflatoxin were provided to the inspectors for verification. In addition, Iraq provided the locations where the unilateral destruction of bulk agents, including *Bacillus anthracis*, botulinum toxin, *Clostridium perfringens* and aflatoxin, had taken place. These included two dump sites at Al Hakam and destruction sites at Al Azzizziyah firing range (75 km south-east of Baghdad) and Al Nibai desert (50 km north-west of Baghdad).

25. In 1996, United Nations inspectors took samples from Al Hakam disposal and dump sites. Analysis of those samples indicated that certain areas of the site did contain elevated levels of *Bacillus anthracis* spores. In addition, sampling and analysis of the fragments of biological munitions unilaterally destroyed by Iraq revealed the presence of DNA fragments of *Bacillus anthracis* and *Clostridium botulinum*. However, owing to the extent of the destruction carried out by Iraq and the lack of records relating to those activities, it was not possible to quantify fully all aspects of Iraq's account of its unilateral destruction, including quantities of bulk agents and numbers of munitions.

26. It should be noted that fragments of destroyed biological munitions were first inspected, but not recognized as such, by inspectors in 1992, when these had been claimed by Iraq as part of the chemical munitions. However, no samples of those fragments were taken for analysis until after Iraq admitted to the weaponization of biological warfare agents. In addition, dozens of empty R-400 bombs produced for biological warfare purposes had been destroyed under the supervision of United Nations chemical weapons inspectors as early as October 1991. At that time, the inspectors had not fully understood or appreciated the specific features and markings — black stripes — and the different internal coating found in some of the bombs.

27. With regard to Al Hussein missile warheads filled with biological warfare agents and later unilaterally destroyed by Iraq, in 1992 inspectors verified the number of fragments which Iraq declared to have been from chemical warheads. Since there were no distinctive physical differences between chemical and biological warheads and inspectors were still unaware of any biological weaponization, the true nature of those warhead fragments was not investigated further. Following Iraq's admission in 1995 of the weaponization of Al Hussein warheads with biological warfare agent and their later unilateral destruction in 1991, inspectors sampled warhead fragments and obtained samples found to be positive for the DNA of *Bacillus anthracis*.

28. In order to account for the 157 declared R-400 biological bombs said to have been filled with various biological warfare agents, Iraq began a re-excavation programme at Al Azzizziyah firing range in February 2003. Iraq unearthed and UNMOVIC verified remnants which included eight intact bombs and various bomb components such as base plates, tails and nose cones that, in total, accounted for 104 bombs. The Special Commission had previously verified 24 bombs at the site. Therefore United Nations inspectors had verified 128 bombs out of the 157 declared as having been destroyed there unilaterally. The remaining, unaccounted-for bombs were stated to be located at the airfield and in a state similar to that of the other bombs found. While Iraq continued excavation in search of further remnants of the bombs, none were found by the time the inspectors were withdrawn from Iraq in March 2003. It has been assessed by UNMOVIC on the basis of sampling results from other bombs that, even if the bombs had remained intact, any biological agent they might have contained would have degraded and would no longer be viable.

29. In 1995, Iraq declared two projects carried out in 1990 to investigate the modification of a MiG-21 fighter aircraft into an unmanned aerial vehicle and the conversion of a Mirage F-1 drop tank for the dissemination of biological warfare agents. United Nations inspectors found no evidence that those two projects were continued after 1991. Iraq also declared the development by the Technical Research Centre of smaller remotely piloted aerial vehicles in the late 1980s. Of concern to United Nations inspectors was the association between the organizations that managed and supported remotely piloted and unmanned aerial vehicle programmes and those formerly involved in Iraqi biological weapons programmes.

30. After 1991, Iraq continued several remotely piloted and unmanned aerial vehicle projects, including the conversion of the L-29 aircraft, and the development of several smaller drones for air defence training. While there was some concern on the part of United Nations inspectors that the L-29 project could have been a follow-on to the MiG-21 unmanned aerial vehicle project, no evidence linking the L-29

with the chemical and biological weapons programme was found. Information gathered by the inspectors suggested that the purpose of the smaller, more recent projects post-1998 (for example, the RPV-20) was related to conventional military applications such as air defence training, data collection and surveillance. No evidence was found that Iraq had developed these systems for the delivery of biological warfare agents.

31. With regard to agent production, United Nations inspectors had concerns that more bulk agent might have been produced than declared by Iraq and that the bulk agent might not have been destroyed as declared. If anthrax spore were preserved and stored in optimal conditions, it could have been viable for many years, leaving the possibility that, with improvements in Iraq's spray-drying capabilities after 1992, the bulk agent could have been dried. UNMOVIC found no evidence to suggest that bulk agent was stored in a manner other than declared. While some evidence was obtained by United Nations inspectors of possibly more production than declared, it would appear that all bulk agent was destroyed in 1991. No evidence was obtained by the United Nations inspectors that Iraq had spray-dried agent in bulk. The United States-led Iraq Survey Group searching for Iraqi weapons of mass destruction made similar findings, with the addition of statements on the destruction of anthrax near a presidential palace at Radwaniyah in Baghdad, in 1991.

32. The inspectors also ensured that facilities, equipment and materials known to have been used by Iraq in the past for its biological weapons programme were destroyed or rendered harmless under United Nations supervision. United Nations monitoring and verification of Iraqi biological activities found no evidence that proscribed biological warfare activities were resumed after 1991. United Nations inspections combined with sanctions may have been a deterrent to Iraq in continuing its biological weapons programme.

33. Verification in the biological area is inherently more complex than in the chemical or missile areas, where concern is focused mainly on the destruction of weapons, bulk agent and precursors, or missile systems or components. However, in the biological area the concept of verification also includes the fact that biological agents are self-replicating and that large amounts of bulk agents can be produced from a single vial of seed stock. Therefore, the confidence in the total verification process depends to a large extent on accounting for reference strains and seed stocks of micro-organisms.

34. United Nations inspectors were able to verify parts of the declarations with respect to Iraq's use of and subsequent destruction of master and working seed stocks. However, they had noted that accounting for all seed stock obtained from open vials would be virtually impossible, as it could have been widely distributed as secondary seed stock throughout Iraq. As a consequence, the issue remains part of the residue of uncertainty with respect to the continued existence in Iraq of seed stocks that could possibly be used in the future for the production of biological warfare agents. In addition, in the biological area all production equipment and materials are inherently dual-use and therefore there are no unique features or markers which point unambiguously to proscribed activities. These issues could best be dealt with through monitoring to detect, inter alia, any possible future activity associated with biological weapon agent production or significant related laboratory research work. In contrast, in the missile and chemical areas, there are some

precursor chemicals or missile components or types of equipment which are clearly only used for proscribed purposes.

35. From the adoption of resolution 687 (1991) until the commencement of biological inspections, Iraq had time to eliminate much of the evidence of past activities at facilities used in its biological weapons programme. Thus, prompt commencement of inspection and verification activities at newly declared or identified facilities is essential, especially for biological inspections. The availability of qualified and trained inspectors for deployment at short notice and well-established sampling and analysis capabilities and procedures, both within the inspection team and in outside laboratories, are required.

36. Diversified expertise within the inspection teams is needed, comprising not only trained experts in the biological warfare field but also specialists in scientific and technical areas relevant to specific activities such as those declared by Iraq at Al Hakam. Expertise in an area such as the production of single-cell protein would be required to ascertain whether a facility like Al Hakam fits its declared status and purpose by its design, construction, equipment, staffing and budget.

37. Additional experience gained by the United Nations relates to sampling and analysis, which carries the notion of scientific argument and thus has a strong influence on a final assessment. Results of sampling, however, need careful analysis as both false positive and false negative results can occur. In addition, a limited sampling strategy risks missing relevant information and may even be counter-productive. An adequate sampling policy comprising environmental, background and investigation-related points at facilities used by Iraq for its biological weapons programme could have enhanced the chances of detecting proscribed materials at an earlier stage. Likewise, the use of more than one reference laboratory for analysis reinforces confidence in the results obtained.

38. To be effective, sampling and analysis require sufficient preparation, trained inspectors and the constant updating of analytical procedures. Even the results of extensive sampling and analysis may be limited, owing to the technical limitations of the analytical methods available and used at a given time. In view of the rapid developments in biotechnology and in particular the associated diagnostic and analytical techniques, it is desirable to keep samples for a sufficient period of time in case new, more sensitive methods of analysis are developed.

39. Considerations related to the low level of biological containment were major factors in the initial perception of the unsuitability of Iraq's dedicated biological weapons production facilities for the production of pathogens. These considerations were drawn from microbiological and manufacturing practices and standards familiar to the inspectors, who were experts on biological weapons.

40. The assumptions regarding the unsuitability of Iraq's dedicated biological weapons production facilities were reinforced by the lack of evidence at the time that Iraq had progressed beyond research and development of biological warfare agents. In the absence of such conclusive evidence, it was difficult to assess that Al Hakam was a biological weapons production facility or that Iraq had produced bulk agent or had biological weapons, until 1995. As was subsequently explained by Iraq, it produced liquid bacterial biological warfare agents accepting a moderate risk of airborne contamination.

41. United Nations inspectors found no evidence that Iraq produced dry bacterial warfare agents. Forensic sampling and analysis of spray-drying equipment present at Al Hakam in 1996 revealed no traces of biological warfare agents. The spray dryers at Al Hakam lacked the required biological safety containment features, which Iraqi scientists recognized as a necessary condition for their own protection. In addition, no evidence of biological munitions filled with dry agents was found. However, since all biological munitions were destroyed unilaterally by Iraq without United Nations supervision, it was not possible to determine whether weaponized biological warfare agents were in liquid or dry state. This did not ease inspectors concerns on the level of Iraq's achievements until, in 1997, three bombs filled with liquid and chemically inactivated botulinum toxin were unearthed from the destruction site declared by Iraq and sampled. In addition, in 2003, bombs filled with chemically inactivated *Bacillus anthracis* in liquid form were also excavated and sampled. Thus, the positive verification of two liquid biological warfare agents found in munitions reduced the concern that Iraq had produced dry agent.

42. In the absence of sampling and analysis, finding the evidence to uncover Iraq's biological weapons programme was difficult. In particular the detection of the conversion of a legitimate biological facility for biological warfare purposes turned out to be especially difficult since such activities took place only for a short period of time, and the site required only minor adjustments for the production of a biological warfare agent. While modern analytical and detection techniques have advanced significantly in recent years, so too have advancements in technology which could make detection much more difficult, such as "clean-in-place" capabilities and disposable production systems, thus presenting new challenges for the future.

43. Since Iraq did not deploy any weapons systems specifically designed for the dissemination of biological aerosols, and initially did not declare the existence of any biological weapons, United Nations inspectors were not aware of nor did they identify the R-400A bombs as biological delivery munitions. The inspectors accepted Iraqi statements that the empty bombs present at the Muthanna State Establishment were part of the chemical weapons arsenal, since those munitions were mainly adapted from the chemical weapons programme located there and because of their design and construction, they were not capable of efficiently disseminating biological aerosols. Thus, those weapons were not identified as being biological munitions by the inspectors who first observed them in 1991. With regard to specific munitions and devices, a thorough evaluation of all weapons which could be adapted for biological warfare purposes is required to identify possible biological munitions through their specific features and signs, such as internal coating and unexplained markings.

44. If a deception campaign is actively pursued, the probability of finding hard evidence of activities related to biological warfare is minimized. An important technical tool that could have helped to identify such facilities is extensive forensic sampling and analysis. Iraq was well aware of the possibility of inspectors taking samples and tried to remove any traces of the agent by thorough decontamination of the facilities. In the future, it is possible that it may be even more difficult to obtain evidence through sampling despite improvements in detection and analysis. It has become clear through the experience of United Nations inspections that inspectors should not confine themselves to sampling evidence alone. If information exists, it may also be gleaned through secondary sources or an amalgam of interviews,

searches of financial records, documents, procurement records, or by examining personal associations and hierarchical structures.

45. The account of the United Nations verification indicates that, under a comprehensive and intrusive international inspection regime, Iraq could not completely hide its biological weapons programme. Although it has not been possible to answer satisfactorily all outstanding questions concerning Iraq's biological weapons programme, such as total quantities of bulk agents produced, weaponized and destroyed, and the disposition of all biological seed stocks, etc., the inspectors were able to discover evidence of a programme larger than had been declared by Iraq and to develop effective lines of investigation that led Iraq to eventually admit the bulk production of biological warfare agents.